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(54) PANEL STRUCTURE AND BUILDING STRUCTURES MADE THEREFROM

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ABSTRACT

An improvement in panel structures and an improved building structure are shown. Rigid foamed plastic building panels are disclosed which consist of rigid foam insulation material sandwiched between generally parallel, opposite framing members recessed within the surface of the foam insulation material.

This invention relates to improvements in panel structures and to improved building structures made therefrom.

It is a principal object of the present invention to provide a building system which combines low cost on-site construction with high performance materials to create an energy-efficient building system usable under a wide variety of climatic conditions.

It is a further object of the invention to provide a building system which permits either on-site or prefabricated construction of buildings usable as residential houses, recreational units, mobile units, construction camp units, hospitals, schools, warehouses and the like.

It is a further object of the invention to provide a building system which makes possible the use of semi-skilled labour and requires no special lifting or construction equipment.

The present invention, among other things, provides a unique form of building panel structure, which panel structure is usable to form the side walls, roof, interior partitions and, optionally, the floor of a building structure.

In one aspect of the invention there is provided an elongated load bearing composite building panel structure comprising rigid foamed plastic slab means of heat insulating material, and spaced generally parallel, elongated rigid structural load bearing framing members surface bonded directly to said slab means and being recessed within opposite major surfaces of said slab means whereby said heat insulating material occupies substantially the entire space between said framing members for providing an effective thermal barrier of relatively low heat conductivity between the opposite framing members all along the entire building panel structure.

In a further aspect of the invention there is provided an elongated load bearing composite building wall structure comprising in combination rigid foamed plastic slab means of heat insulating material, said slab means having at each of its opposite major surfaces a plurality of distinct spaced outwardly open oppositely disposed parallel grooves extending in the load bearing direction, and elongated rigid load bearing framing members surface bonded directly to said insulating material within said grooves whereby said heat insulating material occupies substantially the entire space between said framing members, thereby providing an effective thermal barrier of relatively low heat conductivity between said framing members all along the wall structure.

A building panel structure in accordance with a typical embodiment of the invention includes a plurality of elongated slabs of rigid structural foam insulating material. Each slab includes a pair of major surfaces with a pair of recesses being disposed along each of the longitudinal side edges of the slab to define a tongue extending therealong, each such tongue projecting outwardly from a mid-thickness rejion of the slab. The slabs are disposed in side-by-side relation with the tongues of the respective slabs being in opposed abutting relationship

and the adjacent recesses together defining opposed grooves located at the junctions between the slabs. A rigid framing member is disposed in each of these grooves with the opposing pairs of framing members serving to "sandwich" the abutting tongues of the adjacent slabs therebetween. Suitable means are provided for securing each member of the opposed pairs of framing members relative to the tongues of insulating material which are sandwiched therebetween. The tongues of foam material serve to provide a thermal barrier between the framing members.

Preferably, each framing member comprises a tubular metal member although in some embodiments alternative structural materials such as wood or reinforced plastics could be used. Furthermore, in the preferred form of the invention, a suitable adhesive material serves to bond each framing member to the foam material next adjacent thereto.

In a typical embodiment of the invention, the slabs of foam material comprise precut rigid polystyrene sheets. The framing members typically comprise galvanized tubular steel members. These tubes are interconnected by chemical welding to the polystyrene material. Pairs of perimeter framing members which typically comprise galvanized steel angles are fastened to the ends of the respective tubes and are chemically bonded to the foam along the perimeters of the panel structure. The system enables thermal bridging to be kept to an absolute minimum. The above-noted tongues of foam material serve to separate the pairs of framing members from one another and the steel angle members located at the perimeters of the panel are likewise spaced apart in the thickness direction of the panel thereby to avoid any substantial degree of heat flow from the interior to the exterior of the structure.

The building system of the present invention may be used with a wide variety of foundation systems as, for example, concrete slab on-grade, below grade foundations, pier supports, or granular base.

As noted above, the framework of the building system preferably comprises tubular steel. Tubular steel configurations combine high strength, stability and light weight and they may, of course, be galvanized to protect same against deterioration from corrosion. Tubular sections of the required strengths are determined depending upon the stresses and design criteria in any given location. Lateral bracing is provided to give the necessary stability against wind and earthquake loads. To achieve lateral stability against wind loads, a metal strap is installed in certain of the roof and wall panels, the gauge and width of the strap and the number of fasteners connecting same to the metal framing members of the walls and roof is determined by the anticipated wind loads on the wall and roof.

As noted previously, building panels in accordance with the invention are designed to be used as floor, wall and roof systems. The panel thickness can be adjusted depending upon climatic conditions and building code requirements in the jurisdiction in which the building is being erected.

Panel structures in accordance with the invention incorporate rigid foam insulating material as a major part of the construction. The preferred material is expanded polystyrene which, as is well known, is produced from small beads that are thermally expanded and fused to form large blocks which are then cut into any desired size and thickness. Rigid foam insulation material has one of the lowest thermal conductivities of all common insulation materials thus making it a most versatile cost-efficient insulation as well as providing a substantial degree of structural strength.

The invention further comprises building constructions employing building panel structures as described above for at least one of the following: side walls, roof, interior partitions, and floor.

A method of constructing a building panel structure in accordance with a further aspect of the invention includes providing a plurality of elongated planar slabs of rigid structural foam insulating material as described above. A first set of elongated rigid framing members are located in spaced parallel relation, the spacing therebetween being related to the lateral dimension of each said slab. A plurality of the slabs are positioned in side-by-side generally co-planar relation with said tongues of the respective slabs disposed in opposed abutting relationship such that the adjacent recesses together define first and second opposed sets of grooves located at the junctions between the slabs. The slabs are positioned such that each of the framing members of said first set is disposed in a respective one of said first set of grooves. Individual framing members of a second set are then positioned in each one of the second set of grooves so that opposed pairs of the framing members serve to sandwich said abutting tongues of the adjacent slabs therebetween. Each member of the opposed pairs of framing members is secured relative to the tongues which are sandwiched therebetween so that the tongues of foam material serve to provide a thermal barrier between the framing members. The securement means preferably comprises a suitable adhesive bonding agent which interacts between the framing members and the rigid foam material.

As noted previously, the system of the present invention is adaptable to both pre-fabrication or on-site construction. On-site construction preferably involves

building each wall panel on the previously constructed base or sub-floor. As each wall panel is completed it is raised and secured in position to the base and abutting walls. Upon completion of exterior and interior load bearing walls, the roof panels are constructed and secured to the walls. Then windows and exterior doors are positioned and exterior siding or finish applied; facia and soffit are secured followed by the application of the roofing material.

Pre-fab erection entails similar procedures as above with some variations in fastening methods. Smaller panels can be factory assembled and transported to the building site.

Insofar as the exterior and interior finishes are concerned, various fire-rated finishes can be applied to the ceiling and walls as pre-formed sheets, stucco or paint spray applications, hand brushed or trowelled finishes. Roofing may be galvanized or pre-painted steel, asphalt shingles or other similar roofing materials. Any conventional type of flooring, windows and doors can be incorporated into the building system. Glass fiber reinforced acrylic resin coatings are particularly suitable for use on the exterior and interior surfaces of the polystyrene foam slabs; however, various other types of finishes, as noted above, are also suitable.

Typical embodiments of the invention will now be described, by way of example, with reference to the accompanying drawings in which:

Fig. 1 is a perspective view of a building panel structure made in accordance with the principles of the present invention;

Fig. 2 is a section view taken along line 2-2 in Fig. 1 and looking in the direction of the arrows;

Fig. 3 is a section view taken through a portion of a building constructed in accordance with the principles of the present invention;

Fig. 4A is an enlarged cross-section view of the eave portion of the building structure illustrated in Fig. 3 ;

Fig. 4B is a somewhat more detailed cross-section view of the wall to roof connection for the structure shown in Fig.3;

Fig. 4C is a section view illustrating the interior panel to roof construction and the structure at the ridge line of the roof;

Fig. 4D illustrates, in section, the base to outside wall connection;

Fig. 4E illustrates, in section, the base to inside wall structure;

Fig. 4F illustrates, in section, the roof panel to gable end connection;

Fig. 4G illustrates, in section, a portion of the roof panel illustrating the metal framing members;

Fig. 4H illustrates, in section, outside wall panels at an outside corner of the building;

Fig. 4H' illustrates a modified form of outside

corner construction;

Fig. 4I illustrates, in section, a junction between an outside wall and an interior vertical partition;

Fig. 4I' is similar to Fig. 4I and illustrates a somewhat modified form of outside wall to interior panel connection;

Fig. 5 is a perspective view of typical outside wall panel configurations secured to a suitable base;

Figs. 6A and 6B are diagrammatic views illustrating the application of tension braces to certain of the structural panels of the building;

Fig. 6C illustrates a portion of a panel frame construction including a diagonal tension brace thereon;

Fig. 7 is a partial cross-sectional view of a building panel structure illustrating the manner in which such panels may be partially pre-fabricated and shipped in a partially assembled manner;

Fig. 8 is a perspective view of a portion of the building structure which will assist in understanding the construction erection sequence;

Figs. 8A through 8G (including Figs. 8B(1-4) are diagrams illustrating the sequence of construction of a building system in accordance with the present invention;

With reference now to the drawings, Figs. 1 and 2 illustrate a building panel structure 10 in accordance with the principles of the present invention, which basic form of panel construction, with minor variations, may serve as the side walls, roof, interior partitions and, if desired, the floor of a building structure.

As best seen in Figures 1 and 2, the panel structure 10 comprises a plurality of elongated slabs 12 of rigid structural grade polystyrene foam insulating material. Each slab 12 includes an opposing pair of major surfaces 14 with a pair of recesses 16 being disposed along each of the longitudinal side edges of each slab 12 to define a tongue portion 18 extending therealong. As best seen in Fig. 2, each such tongue portion 18 projects outwardly from a mid-thickness region of the slab. The slabs 12 are disposed in side-by-side co-planar relationship with the tongues 18 of the respective slabs being disposed in opposed abutting relationship. The adjacent recesses 16 together define opposed grooves located at the junctions between the slabs 12. A rigid framing member 20 is disposed in each of these grooves with the opposing pairs of framing members 20 serving to sandwich the abutting tongues 18 of adjacent slabs 12 therebetween. A layer 21 of suitable adhesive material serves to secure each framing member 20 of the opposed pair of members to the tongue 18 of insulating material which is sandwiched therebetween. The tongues 18 of polystyrene foam material serve to provide a thermal break or barrier between the framing members 20.

With further reference to Figure 2 it will be noted that each framing member 20 comprises a hollow tubular member of rectangular cross-section. Each framing member 20 is preferably galvanized thereby to resist corrosion. It will be

further noted from Fig. 2 that that surface of each framing member 20 which is directed outwardly of the panel is generally flush with the associated major surfaces 14 of the slabs of polystyrene associated therewith.

As best seen in Fig. 1, each of the opposing ends of the panel structure 10 has a pair of rigid perimiter framing strips extending therealong. The respective pairs of perimeter framing strips are designated by reference numbers 22 and 24 in Fig. 1. In the embodiment of Fig. 1 these perimeter framing strips take the form of galvanized steel angle members. It will be noted that they are spaced apart in the direction of the thickness dimension of panel 10 thereby to provide a thermal break therebetween. These pairs of perimeter framing strips 22, 24 are also adhesively bonded to the polystyrene foam slabs. It will also be noted that the opposing ends of the framing members 20 are connected to associated ones of the pairs 22, 24 of perimeter framing strips so as to maintain the thermal break. The connection between the perimeter framing strips 22, 24 and the associated framing members 20 may be made by any suitable means such as by spot welding, riveting, or by self-threading screws etc.

The structural properties of rigid polystyrene insulation material are well known. The Dow Chemical Company, for example, manufactures a wide variety of polystyrene foams suitable for use in building construction. Since the foam material will be subject to a certain degree of shear stress, especially at the interface between the foam and the framing members 20, particularly when the panel as a whole is subject to bending stresses as, for example, when such panels are used to form the roof sections of the building, the polystyrene foam should exhibit a substantial degree of shear strength depending of course on snow loadings, roof design etc. Numerous foams are available commercially which have a shear

strength of about 35 pounds/square inch and which have a thermal resistance R equal to or greater than 5.00 per one inch of thickness when measured in hours/square foot/degrees Fahrenheit/BTU. This material will usually have a compressive strength of about 30 psi minimum and a tensile strength of about 60 psi minimum. The average shear modulus will be in the order of 1200 psi (ASTM-C-273-61).

Numerous adhesives are commercially available for bonding the polystyrene foam to the metal framing members. One highly suitable adhesive is known as "FLINTSTIK" (registered trademark) No. 230-21 made by The Flintkote Company of Canada Limited. This adhesive is a solvent-type synthetic rubber-based insulation adhesive. This material can be applied at temperatures down to 10° Fahrenheit. The material sets rapidly to give a strong resilient bond, the strength of which will exceed the shear strength of the polystyrene foam. The adhesive material should be applied to substantially the full length of each framing member thereby to provide an adequate bonding area between the metal and the foam.

The above basic panel construction, with minor modifications, may be used to form the walls, roof, internal partitions and, optionally, the floor of a building structure.

Although not illustrated in Figs. 1 and 2, the opposing major surfaces of the panel 10 may be coated with a skin of glass fiber reinforced synthetic resin thereby to protect the polystyrene foam from structural damage and to provide added strength to the structure. Preferably, the opposing surfaces of the panel are covered with a glass reinforced acrylic resin coating having a thickness from about 3/16 inch to about 1/2 inches.

A typical building structure in accordance with the

principles of the invention is illustrated in Fig. 3 with further details of such structure being shown in Figs. 4A-4I, Fig. 5, and Figs. 6A-6C.

With reference to Fig. 3, it will be seen that the building structure includes exterior load bearing wall panels 10a, roof panels 10b, and interior load bearing panels 10c. The end walls of the building are not shown in Fig. 3 nor are any additional interior partitions shown.

With further reference to Figs. 4A, 4B, 4B", and 4D it will be seen that the exterior load bearing wall panel 10a includes polystyrene foam slabs 12a as described previously in relation to Figs. 1 and 2 and is provided with vertically spaced pairs of tubular framing members 20a. The upper edge of exterior wall panel 10a is provided with a cap comprising spaced apart perimeter framing strips 22a while the lower edge of exterior wall panel 10a is provided with a sill comprising a similar pair of framing strips 24a. The outermost framing strip 24a is connected to the concrete slab floor 30 by means of a series of spaced apart pins or "RAMSET" (registered trademark) fasteners. These fasteners are illustrated by reference number 32. The upper peripheral framing strips 22a defining the cap are angled to match the slope of the roof panel 10b. The interior and exterior of wall panel 10a may be covered with a glass reinforced acrylic resin coating 3/16 inch to 1/2 inches thick. The exterior surface of wall panel 10a is also provided with any additional suitable decorative surface such as a decorative stucco manufactured by the Flintkote Company of Canada Limited. This stucco which is preferred is a polymer fortified cement-based product which is mixed witn water before use. Any other suitable form of decorative exterior finish may be used. The interior surface of wall panel 10a may likewise be covered

with any suitable building material as, for example, fiber-board, wall panelling, plasterboard, etc.

In a typical embodiment of the invention, the wall panels 10a utilize 3" thick polystyrene foam insulation with the framing members comprising pairs of 1" by 2" by 18 gauge steel galvanized tubes located at 24" centers. The pre-cut 3" thick polystyrene slabs were provided with tongues having a thickness of about 1" between the opposing tubular framing members 20a. The cap and sill peripheral framing strips 22a and 24a respectively consisted of pairs of 1 3/8" x 1 3/8" x 18 gauge steel angles running continuously and screwed to the tubular steel framing members 20a. The exterior sill peripheral framing strip 24a was connected to the concrete foundation base using 1/8" steel drive pins located at 12" centers.

The roof panels 10b are of similar construction to the wall panels 10a except that they are usually made somewhat thicker thereby to provide additional bending strength. In a typical embodiment designed for a maximum deflection of L/240, the slabs of polystyrene foam had a thickness of 5". Both major surfaces of the roof panels were coated with a glass reinforced acrylic resin coating in the same fashion as for the wall panels. In addition, the exterior surface of the roof panels may be coated with a general purpose heavy duty protective coating such as "FLINTGUARD" 800-48 reinforced asphalt emulsion roof coating. This product is made by The Flintkote Company of Canada Limited.

With further reference to Figs. 4A-4D it will be seen that the roof panels 10b are provided with perimeter framing strips 22b and 24b which are similar to those described previously except that the included angles between the flanges of such members are adapted to suit the pitch of the roof.

The lowermost set of roof panel framing members 20b are screwed to the cap members 22a by suitable sheet metal screws or the like. Suitable aluminum facing members may be applied to the exposed surfaces of the roof panels in a manner which need not be described further here.

With reference to Figs. 4C and 4E, the interior load bearing panel 10c is constructed and functions in much the same manner as the previously described exterior load bearing wall panel 10a. The upper edge of the interior load bearing panel 10c has a cap defined by a pair of perimeter framing strips 22c shaped to match the oppositely directed slopes of the roof panels 10b while the lower edge of wall panel 10c is provided with a sill defined by perimeter framing strips 24c connected to the concrete base by suitably located drive pins. The opposite major surfaces of wall panel 10c are preferably provided with the above-mentioned glass fiber reinforced acrylic resin coating together with such interior surfaces as may be desired.

With reference to Figs. 4F and 4G, the roof panel 10b is shown in transverse cross section, Fig. 4G illustrating the framing tubes 20b in cross section. In certain applications it is desirable to interconnect the opposing pairs of tubes 20b together, as for example, by three or four spaced apart sheet metal screws the latter being designated by reference numeral 36. These interconnecting screws may be used to hold the framing members securely in place while the adhesive material is setting. Similar interconnecting screws may be used in the various wall members as well. Fig. 4F illustrates the edges of roof panel 10b as resting on a building end wall panel 10d. It will be noted that the longitudinal side edges of the polystyrene slabs of the roof panels located adjacent the ends of the building are formed somewhat differently from the longitudinal side edges of the intermediate slabs in that the

tubular framing members are not required but, rather, longitudinally extending frame angle members 38 are provided to impart the necessary structural strength and rigidity. Suitable metal cladding or fascia elements 40 are also shown in Fig. 4F to protect the polystyrene and also provide an attractive appearance.

Fig. 4H illustrates one manner of interconnecting an outside wall panel 10a to a further outside wall panel 10a at the corner of the building. In this particular embodiment, the polystyrene foam slabs next adjacent the outside corner of the building are not provided with recesses and tubular seal framing members as described previously but, rather, are provided with pairs of vertically disposed steel angle members 42 bonded by adhesive to the foam core material. The corner is made secure by a series of fastener elements 44 serving to interconnect together the adjacent angle members 42. In addition, a vertically disposed metal corner cover 46 is provided which extends fully around the corner and is connected to the associated angle members 42 thus further reinforcing the joint at the outside corner.

An alternative form of corner connection is shown in Figure 4H'. In this particular embodiment, the polystyrene foam panels 12a adjacent the corner are provided with the previously described spaced apart pairs of tubular framing members 20a. An upright steel angle member 50 is disposed in the recess defined by the adjacent ends of the two panel members 12a and such angle member serves to interconnect together the two closely adjacent upright framing members 20a. An elongated insulating block of polystyrene 52 is then set into the recess defined by the adjacent ends of the panels and is secured in place by adhesive. An external metal angle cover member 54 is applied over the entire assembly and serves to protect the insulating block 52 from damage.

One method of connecting an interior panel 10c to an exterior wall panel 10a is illustrated in Fig. 4I. In this embodiment, the polystyrene foam panels 12c most closely adjacent the exterior wall are provided with vertically disposed steel angle framing elements 60. These framing elements are attached via sheet metal screws to an associated tubular framing element 20a of the exterior wall 10a.

Fig. 4I' illustrates an alternative form of connection between the interior wall panel 10c and exterior wall panels 10a. In this arrangement, the polystyrene foam panel most closely adjacent the exterior wall is provided with the previously described tubular framing members 20c. This arrangement is used when the interior wall panel 10c comes into abutting relation with the outer wall panels 10a at a location intermediate the spaced apart pairs of tubular framing members 20a of the outer wall panel. In the arrangement shown in Fig. 4I', the tubular framing members 20c are each provided with upper and lower angle connector elements 70 which are connected to respectively associated ones of the associated cap and sill framing strips 22a and 24a of the outer wall. It is also noted here that if required a strap may be fastened from members 20a to additional angle members 70 connected to framing members 20c to provide intermediate support connections at elevations other than the top and bottom of the wall panels 10a and 10c.

The perspective view of Fig. 5 merely serves to further illustrate and clarify the outside corner construction illustrated previously particularly with reference to Fig. 4H.

Figs. 6A-6C illustrate the application of tension braces 80a, 80b, and 80d to the outer wall panels 10a, the roof panels 10b, and the building end wall panels 10d respectively.

It will be seen particularly from Fig. 6B that these bracing straps are provided in each of the panels noted above adjacent the four corners of the building. These tension braces take the form of diagonal steel straps 80 as illustrated in Fig.6C. The steel straps provide lateral stability against wind and earthquake loads. By using the tension braces 80, the roof panels 10b acting as braced diaphragms, transfer lateral loadings to adjacent braced wall panels 10a and 10d which, in turn, transfer the load to the foundation. As best seen in Fig. 6C the tension braces 80 are connected to the exteriorly disposed hollow tubular framing members 20 in the roof and wall panels adjacent the building corners as described with reference to Fig. 6B.

Although building panels according to the present invention are particularly well suited for on-site construction, it is possible to wholly or partially pre-fabricate certain of the panel constructions. Fig. 7 shows a typical view of a partially pre-fabricated panel 10; in order to complete the construction on site the panel section 10' may readily be connected to the panel section 10'' by adhesively bonding the two panel sections together in the region broadly indicated by arrow A and then applying the usual perimeter framing angles.

The erection of a building structure in accordance with the invention will now be described with reference to Fig. 8 and Figs. 8A-8G.

The first step is a fairly conventional one involving the preparation of the necessary grades and the installation of any underfloor services followed by the placing of concrete forms and the pouring of a reinforced concrete foundation and floor slab. Following this, the concrete is

allowed to cure.

A straight line is then established along the long side of the floor slab. The inside tubular framing members 20a are then positioned perpendicular to the straight line at the predetermined intervals, reference being had to Fig. 8B(1). The adhesive material is then applied to framing members 20a and the polystyrene slabs 12a are positioned on top of the framing members 20a, reference being had to Fig. 8B(2). Adhesive is then applied into the grooves of the polystyrene slabs 12a and the second set of tubular framing members 20a is positioned in such grooves. Adhesive is then applied to the perimeter framing strips 22a and the same are positioned along the top perimeter of the aligned polystyrene slabs 12a. These perimeter framing strips 22a are then fastened to their associated framing members 20a with self-drilling screws, spot welding or other suitable fastening means. If required at this time, intermediate fasteners e.g. self-tapping screws may be inserted into the opposed pairs of tubular framing members 20a to secure same together, reference being had to Fig. 8B(3). Insofar as the perimeter framing strips 24a forming the sill for the wall panel are concerned, only the inside perimeter framing strip 24a is attached to members 20a at this time. The outside perimeter framing member 24a forming a part of the sill is fastened to the concrete base using steel drive pins as described previously. This is illustrated in Fig. 8B(4).

It should also be noted here that the necessary openings for doors and windows are provided in the desired locations preferably using tubular steel members for top headers in the various openings. These tubular steel members may be spot welded to associated ones of the upright framing members 20a as required. The casings for the doors and

windows may be constructed in basically conventional fashion. Also, at this time, the diagonal tension braces 80 are applied to the outside tubular framing members 20a and secured thereto by spot welding, self-tapping screws or the like as illustrated previously in Fig. 6C.

With reference to Fig. 8C, the entire wall panel 10a is then tilted 90° into an upright position and temporarily braced and then secured to the concrete floor slab by attaching the outside tubular members 20a to the exterior perimeter framing strip 24a, the latter having been previously attached to the concrete base.

The opposing long wall is then constructed and erected using the same procedure as outlined above. Following this, the end wall panels 10d of the building are constructed and erected as outlined previously.

In the preferred arrangement, the various walls are dimensioned so that their inside edges meet as illustrated in Figure 4H' thus enabling the walls to be fastened together with the previously described angle member 50 following which the insulating block 52 is positioned in place and the corner cap 54 applied.

The central load bearing wall panel 10c is then constructed and swung upwardly into an upright position using essentially the same techniques as outlined previously for the outside walls. Appropriate openings in the center load bearing wall are provided as required.

Assuming that the roof is not prefabricated, the bottom tubular framing members 20b are located in parallel relationship at the required spaced intervals and connected to the perimeter framing strips 22a and 22c of the outer and

central load bearing walls respectively. The connection may be made using self-drilling screws, spot welding or other suitable fasteners.

The adhesive material is applied to the tubular framing members 20b and subsequently the polystyrene foam slabs 12b are positioned on top of them in a similar fashion as described previously in connection with the exterior walls. Then the adhesive material is applied to either the top framing members 20b or the polystyrene foam slabs and then these steel members are positioned on the polystyrene foam slabs within the grooves located at the junctions between the respective slabs. At this time intermediate fastener members may be applied to more firmly secure the opposing pairs of tubular framing members 20b together.

If the roof panels have been previously prefabricated it is a simple matter to place same on top of the load bearing wall panels 10a and 10c and to fasten the lower framing members thereof to the perimeter framing strips 22a and 22c as described previously.

Following the above, the diagonal tension braces 80b are applied as described previously in connection with Figs. 6A-6C. Following this, a suitable metal cap member 90, as illustrated in Fig. 4C may be applied along the ridge with suitable fasteners.

At this point, there may be constructed and erected any remaining interior partitions using essentially the same methods as described previously. The structure is now ready for interior and exterior surface applications. If glass fiber reinforced acrylic resin material is to be used this material may be sprayed on using conventional techniques.

The final stages with reference to Fig.8G include installing windows and exterior doors. The exterior finish coatings are applied as well as the roofing materials. The electrical wiring is installed, it being noted here that electrical distribution is preferably provided by means of a surface metal raceway system installed around the perimeter of the house at the base of the walls. Heating is preferably accomplished by means of electrical baseboard systems.

The embodiments of the invention in which an exclusive property or privilege is claimed are defined as follows:

1. An elongated load bearing composite building panel structure comprising rigid foamed plastic slab means of heat insulating material, and spaced generally parallel, elongated rigid structural load bearing framing members surface bonded directly to said slab means and being recessed within opposite major surfaces of said slab means whereby said heat insulating material occupies substantially the entire space between said framing members for providing an effective thermal barrier of relatively low heat conductivity between the opposite framing members all along the entire building panel structure.

2. An elongated load bearing composite building wall structure comprising in combination rigid foamed plastic slab means of heat insulating material, said slab means having at each of its opposite major surfaces a plurality of distinct spaced outwardly open oppositely disposed parallel grooves extending in the load bearing direction, and elongated rigid load bearing framing members surface bonded directly to said insulating material within said grooves whereby said heat insulating material occupies substantially the entire space between said framing members, thereby providing an effective thermal barrier of relatively low heat conductivity between said framing members all along the wall structure.

3. The building wall structure defined in claim 2, wherein said heat insulating material is foamed polystyrene and said framing members are metal adhesively bonded to said heat insulating material within said grooves.

4. The building wall structure defined in claim 3, wherein said grooves are rectangular and said metal members are steel tubes conformably rectangular and of such nature as to fit snugly

within said grooves with their exterior surfaces lying substantially in the planes of said major surfaces.

5. A fabricated composite load bearing panel serving as a building wall or the like comprising an integral slab of rigid foamed heat insulating plastic material having on opposite sides parallel flat major surfaces, at least one pair of laterally opposed substantially parallel recesses in said major surfaces extending from edge to edge of the panel in the load bearing direction, in combination with framing members each securely surface bonded to the slab and substantially occupying said recesses, said foamed plastic material providing a thermal barrier of relatively low heat conductivity between opposed framing members, and said framing members having outer surfaces disposed as substantial continuations of said major surfaces of said slab.

6. A composite building panel structure including a plurality of elongated planar slabs of rigid structural foam insulating material, each slab having a pair of oppositely disposed major surfaces, each said slab having a pair of recesses disposed along each of its longitudinal side edges to define between them a tongue extending along said longitudinal side edge, each such tongue projecting outwardly from a mid-thickness region of the slab, the slabs being in side-by-side relation with said tongues of the respective slabs being in opposed abutting relationship and the adjacent recesses together defining opposed outwardly open grooves located at the junctions between the slabs, and a rigid framing member occupying each of said grooves, opposed pairs of the framing members serving to sandwich said abutting tongues of the adjacent slabs therebetween, and adhesive means for surface bonding each member of the opposed pairs of framing members directly to the foam

material of the tongues which are sandwiched therebetween, the tongues of foam material serving to provide a thermal barrier between the framing members.

7. The structure according to claim 6 wherein first and second sets of the framing members are associated with first and second ones respectively of the major surfaces of the panel structure, the opposing ends of the first and second sets of framing members being attached to respective ones of first and second pairs of perimeter framing strips which extend along opposing ends of the panel structure, the first and second pairs of perimeter framing strips being spaced apart to provide a thermal barrier therebetween.

8. The structure according to claim 6 wherein each framing member is of rectangular section with that surface thereof which is directed outwardly of the panel being generally flush with the major surfaces of the slabs associated therewith.

9. The structure according to claim 8 including a protective skin of material bonded to at least one of the major surfaces of the panel.

10. The structure according to claim 8 wherein each of the opposing ends of the panel structure has a pair of perimeter framing strips extending therealong and spaced apart in the direction of the thickness dimension of the panel to provide a thermal break therebetween, the opposing ends of the framing members being connected to associated ones of said pairs of perimeter framing strips so as to maintain the thermal break.

11. A building structure including load bearing wall panels and roof panels, said wall panels and roof panels each comprising panel structures as defined in any one of claims 1, 5 and 6, the rigid framing members of the wall panels being disposed vertically, and the rigid framing members of the roof

panels spanning certain of said wall panels and being supported thereby.

12. A building structure including load bearing wall panels and roof panels, said wall panels and roof panels each comprising panel structures as defined in claim 10 the rigid framing members of the wall panels being disposed vertically, and the rigid housing members of the roof panels spanning certain of said wall panels and being supported thereby.

13. A building structure according to claim 12 wherein the perimeter framing strips of said load bearing wall panels are disposed along the top and bottom edges of such panels to form the caps and sills thereof respectively, lowermost ones of the framing strips being secured to a floor slab, the wall panels being secured to one another at the corners of the building structure, and said roof panels resting on the top edges of adjacent pairs of the load bearing wall panels and being secured thereto.

14. A method of constructing a building panel structure including providing a plurality of elongated planar slabs of rigid structural foam insulating material, each slab having a pair of oppositely disposed major surfaces, each said slab having a pair of recesses disposed along each of its longitudinal side edges to define between them a tongue extending along each said longitudinal side edge, each such tongue projecting outwardly from a mid-thickness region of the slab, placing a first set of elongated rigid framing members in spaced parallel relation, the spacing therebetween corresponding to the lateral dimension of each said slab, positioning a plurality of the slabs in side-by-side generally co-planar relation with said tongues of the respective slabs in opposed abutting relationship such that the adjacent recesses together define first and second opposed sets

of outwardly open grooves located at the junctions between the slabs, the slabs being further positioned such that each of the framing members of said first set is disposed in a respective one of said first set of grooves, and positioning individual framing members of a second set in each one of the second set of grooves, opposed pairs of the framing members serving to sandwich said abutting tongues of the adjacent slabs therebetween, and surface bonding each member of the opposed pairs of framing members directly to the tongues which are sandwiched therebetween whereby the tongues of foam material serve to provide a thermal barrier between the framing members.

15. The method according to claim 14 including applying adhesive material in such a way that a layer of same becomes interposed between each said framing member and the tongue of foam material next adjacent thereto and allowing the adhesive to set or cure to effect bonding therebetween.

16. The method according to claim 15 including positioning perimeter framing strips along each of the opposing ends of the structure and adhesively securing same to said foam material and also fastening same to the ends of the rigid framing members.

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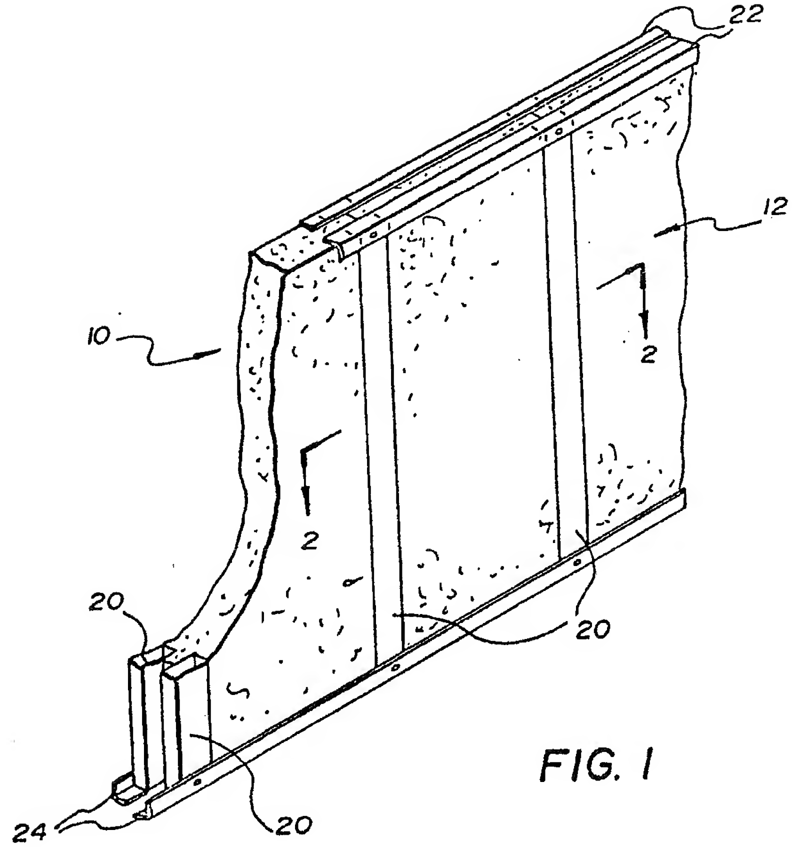

FIG. 1

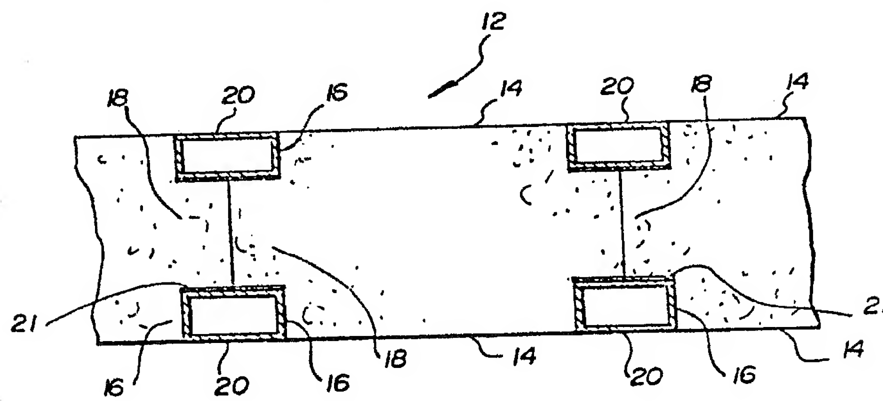

FIG. 2

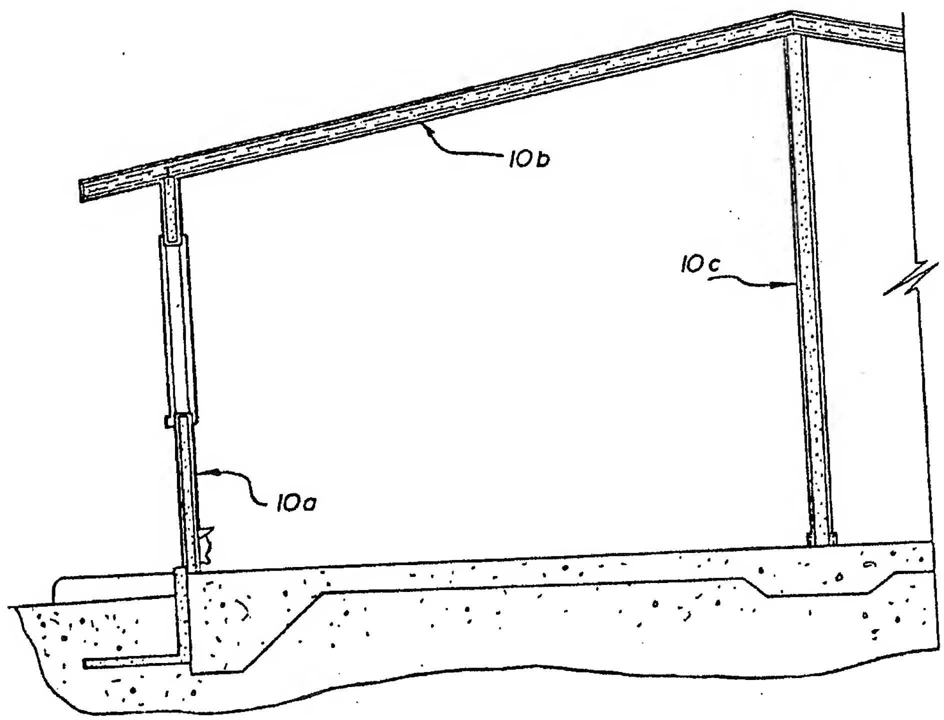

FIG. 3

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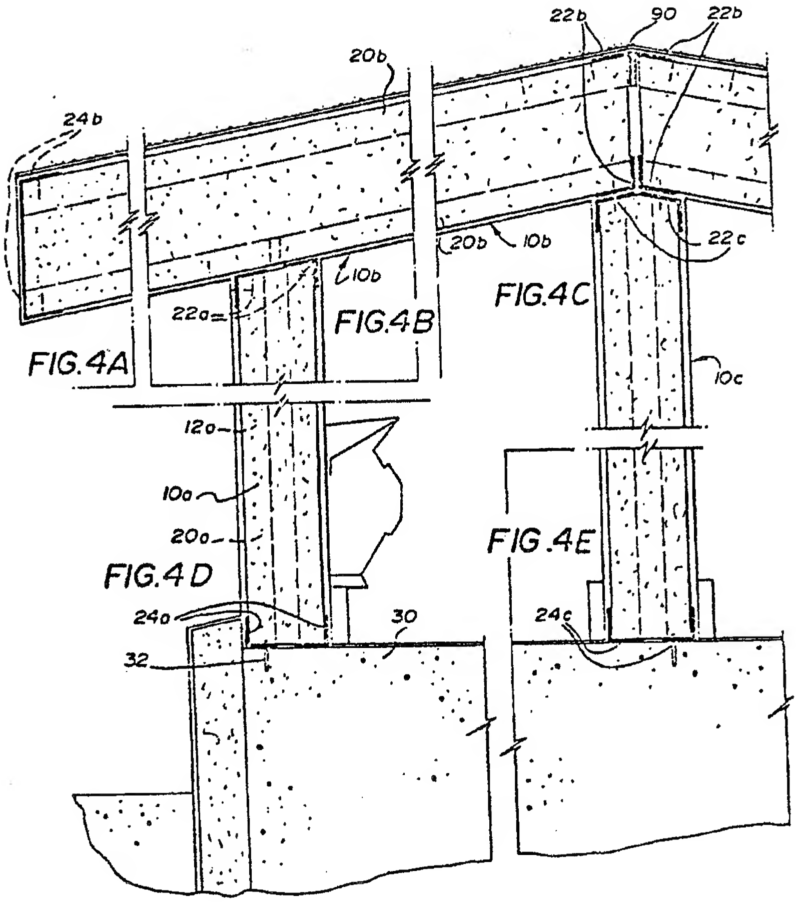

FIG. 4

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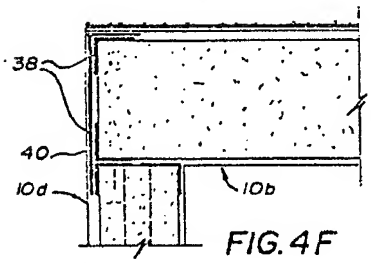


FIG. 4F

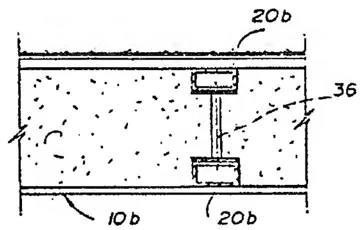


FIG. 4G

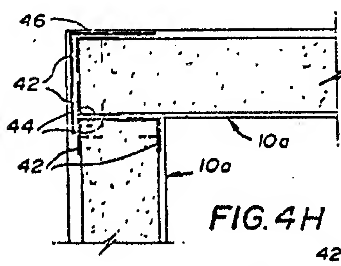


FIG. 4H

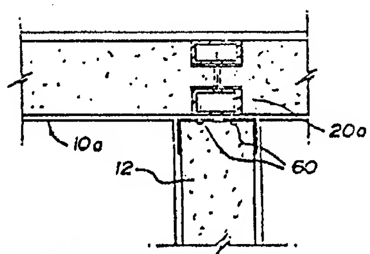
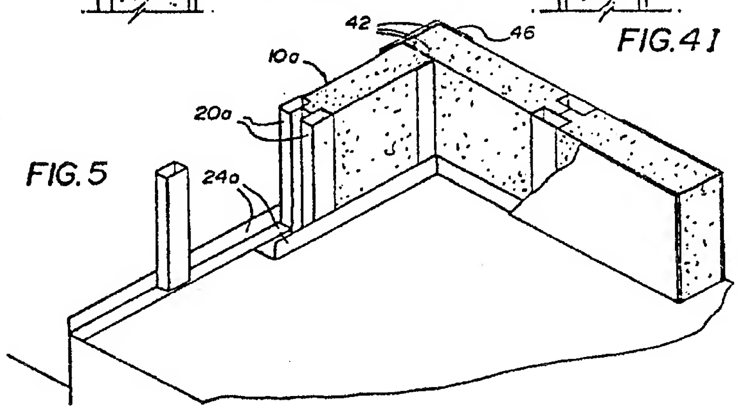


FIG. 4I

FIG. 5



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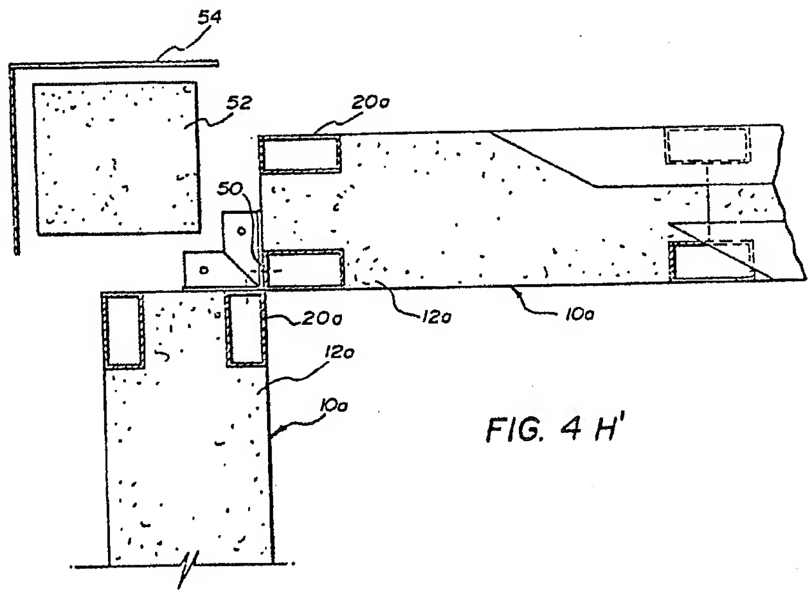

FIG. 4 H'

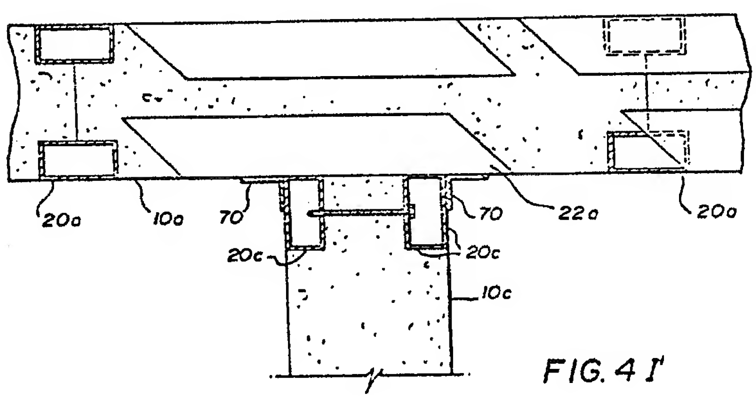

FIG. 4 I'

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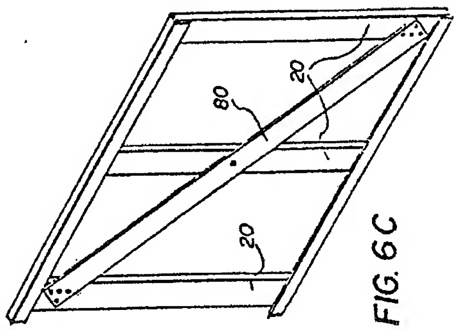

FIG. 6C

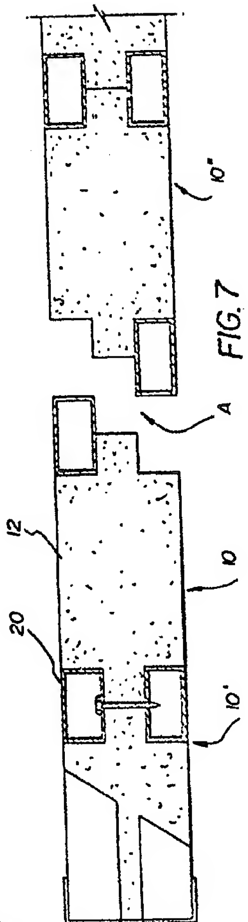

FIG. 7

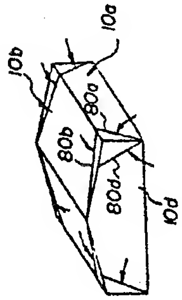

FIG. 6B

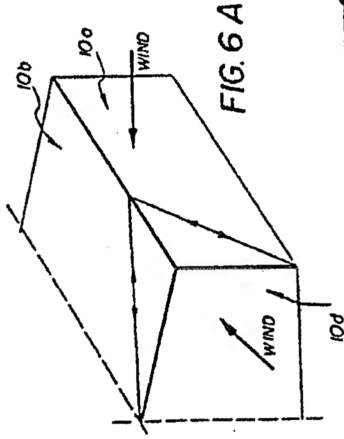

FIG. 6A

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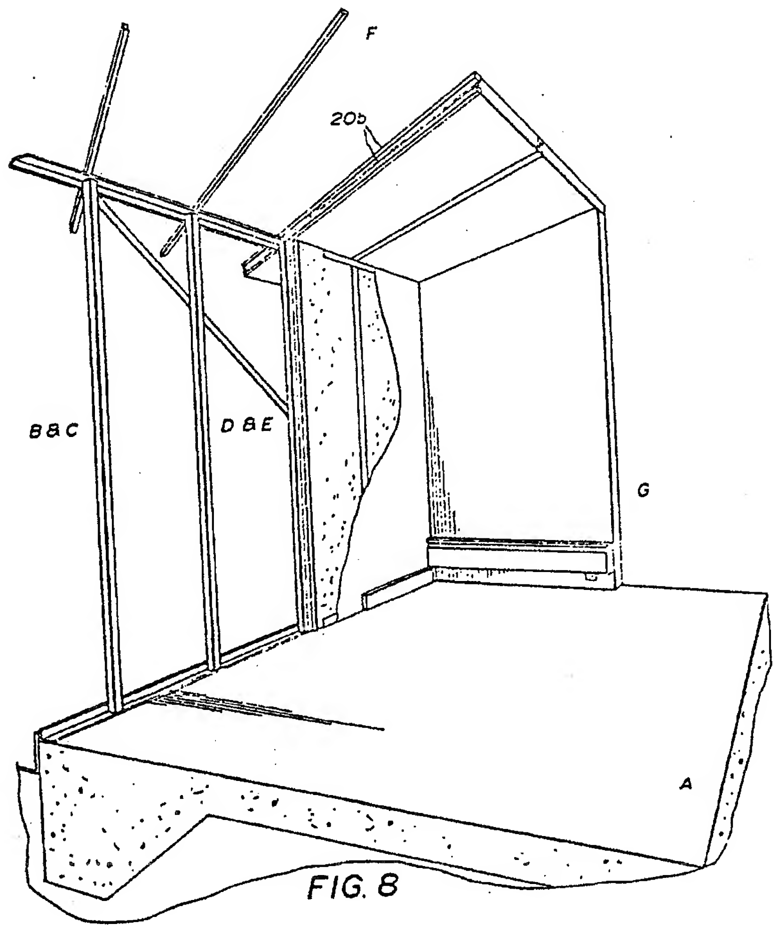

FIG. 8

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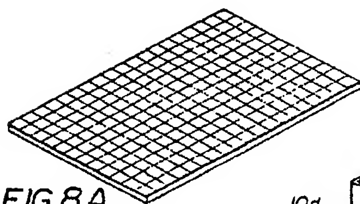
FIG.8A

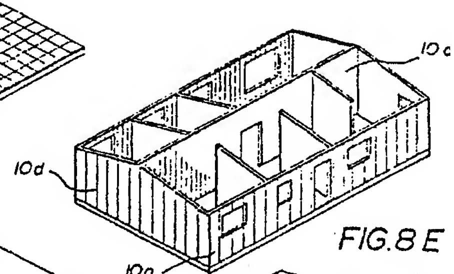

FIG.8E

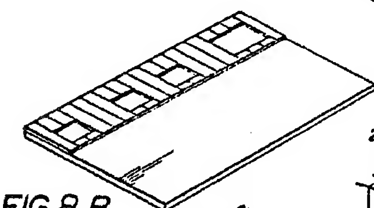
FIG.8B

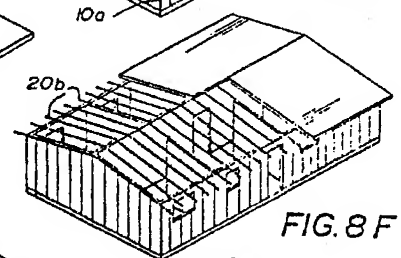

FIG.8F

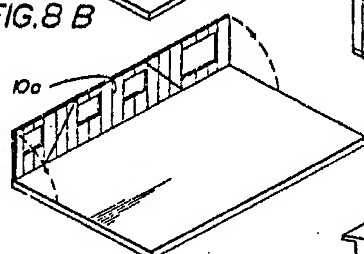

FIG.8C

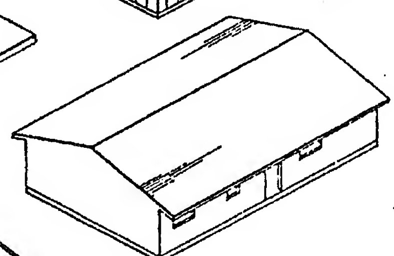
FIG.8G

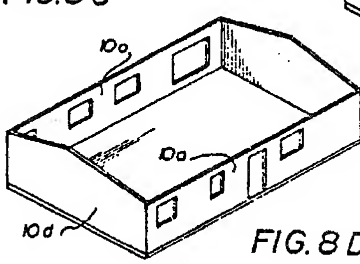

FIG.8D

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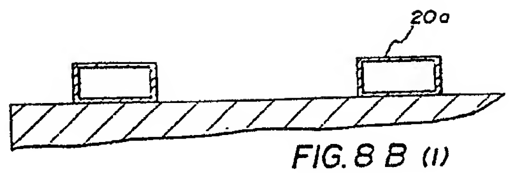

FIG. 8 B (1)

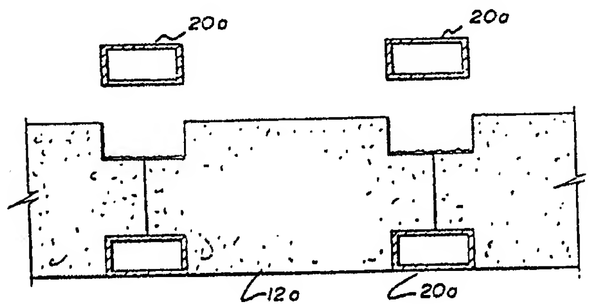

FIG. 8 B (2)

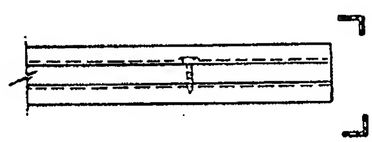

FIG. 8 B (3)

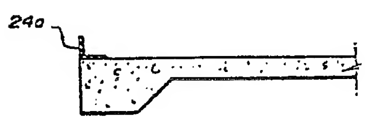

FIG. 8 B (4)